FIG. 1

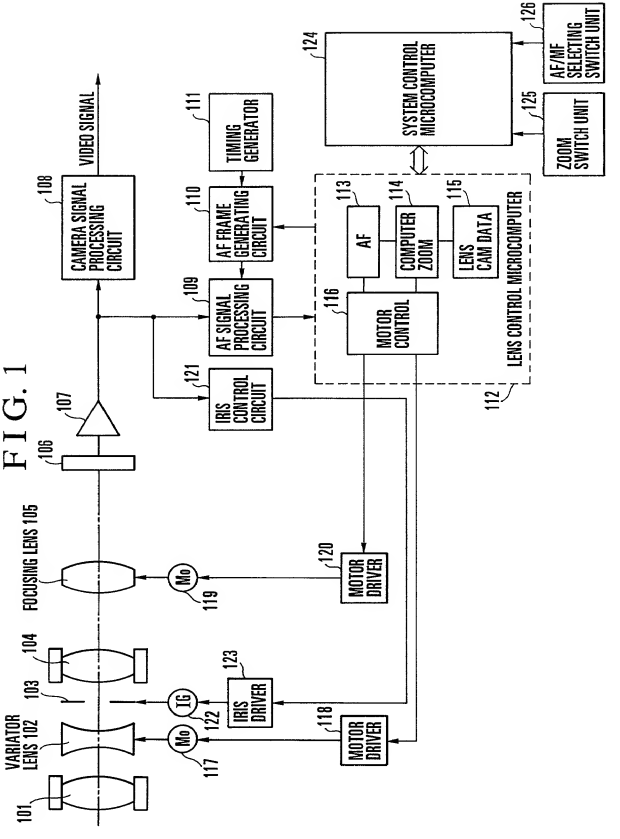

101
VARIATOR LENS 102
103
104
FOCUSING LENS 105
106
107
108
CAMERA SIGNAL PROCESSING CIRCUIT
VIDEO SIGNAL
109
AF SIGNAL PROCESSING CIRCUIT
110
AF FRAME GENERATING CIRCUIT
111
TIMING GENERATOR
112
LENS CONTROL MICROCOMPUTER
113
AF
114
COMPUTER ZOOM
115
LENS CAM DATA
116
MOTOR CONTROL
117
Mo
118
MOTOR DRIVER
119
Mo
120
MOTOR DRIVER
121
IRIS CONTROL CIRCUIT
122
IG
123
IRIS DRIVER
124
SYSTEM CONTROL MICROCOMPUTER
125
ZOOM SWITCH UNIT
126
AF/MF SELECTING SWITCH UNIT

FIG. 2

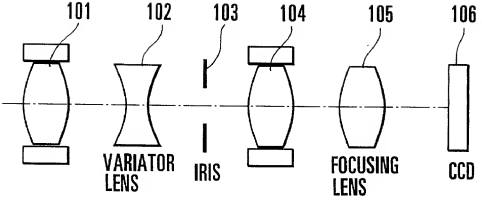

101
102
103
104
105
106
VARIATOR LENS
IRIS
FOCUSING LENS
CCD

FIG. 3

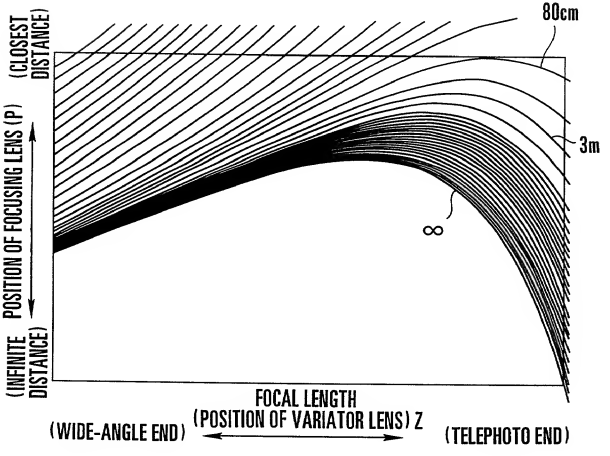

80cm
3m
∞
(CLOSEST DISTANCE)
POSITION OF FOCUSING LENS (P)
(INFINITE DISTANCE)
FOCAL LENGTH
(POSITION OF VARIATOR LENS) Z
(WIDE-ANGLE END)
(TELEPHOTO END)

FIG. 4

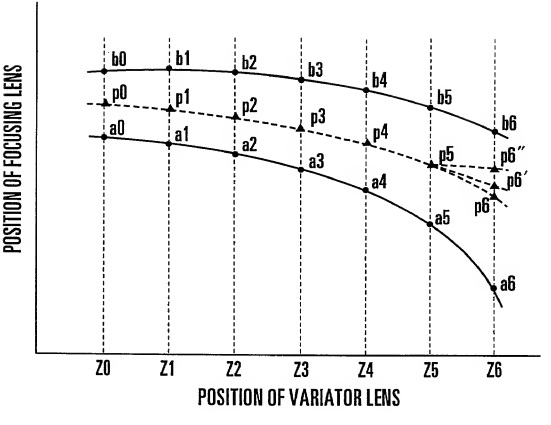
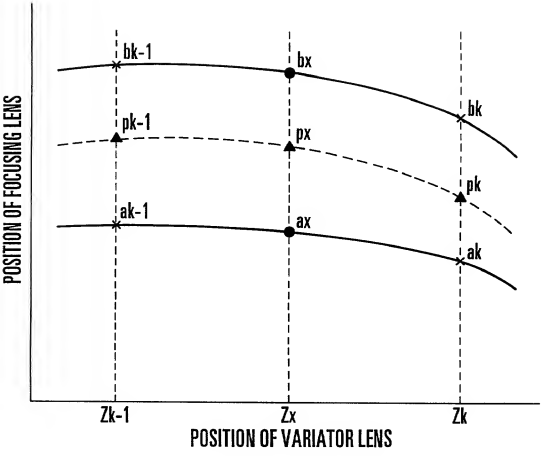

POSITION OF FOCUSING LENS
b0
b1
b2
b3
b4
b5
b6
p0
p1
p2
p3
p4
p5
p6″
p6′
p6
a0
a1
a2
a3
a4
a5
a6
Z0
Z1
Z2
Z3
Z4
Z5
Z6
POSITION OF VARIATOR LENS

FIG. 5



$$ax = ak - \frac{(Zk - Zx)(ak - ak\text{-}1)}{(Zk - Zk\text{-}1)}$$

$$bx = bk - \frac{(Zk - Zx)(bk - bk\text{-}1)}{(Zk - Zk\text{-}1)}$$

FIG. 6(A)

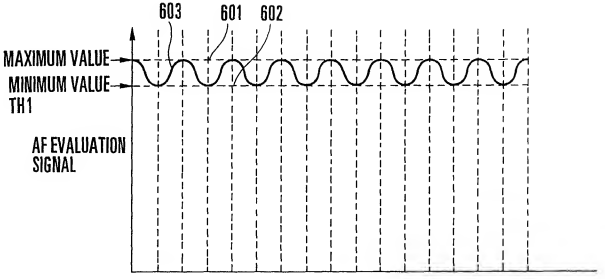


FIG. 6(B)

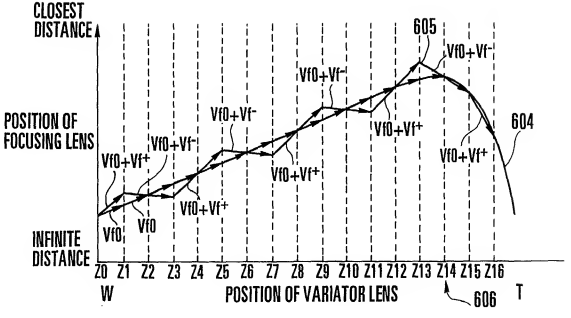


FIG. 7

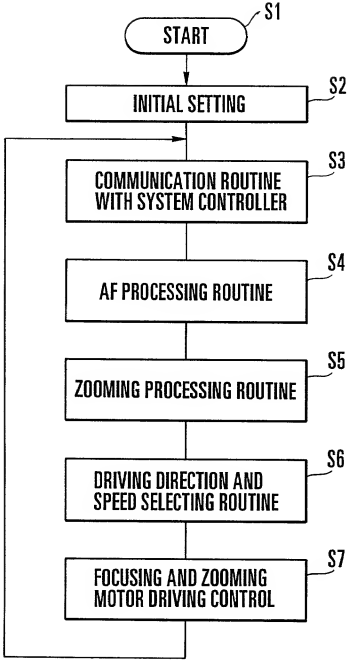

START
S1
INITIAL SETTING
S2
COMMUNICATION ROUTINE WITH SYSTEM CONTROLLER
S3
AF PROCESSING ROUTINE
S4
ZOOMING PROCESSING ROUTINE
S5
DRIVING DIRECTION AND SPEED SELECTING ROUTINE
S6
FOCUSING AND ZOOMING MOTOR DRIVING CONTROL
S7

FIG. 8

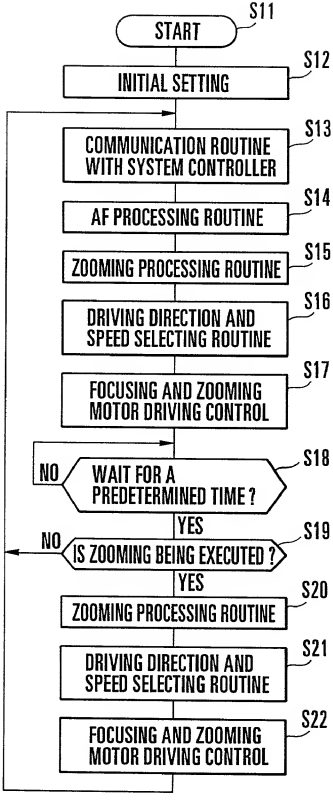

START
S11
INITIAL SETTING
S12
COMMUNICATION ROUTINE WITH SYSTEM CONTROLLER
S13
AF PROCESSING ROUTINE
S14
ZOOMING PROCESSING ROUTINE
S15
DRIVING DIRECTION AND SPEED SELECTING ROUTINE
S16
FOCUSING AND ZOOMING MOTOR DRIVING CONTROL
S17
NO
WAIT FOR A PREDETERMINED TIME ?
S18
YES
NO
IS ZOOMING BEING EXECUTED ?
S19
YES
ZOOMING PROCESSING ROUTINE
S20
DRIVING DIRECTION AND SPEED SELECTING ROUTINE
S21
FOCUSING AND ZOOMING MOTOR DRIVING CONTROL
S22

FIG. 9

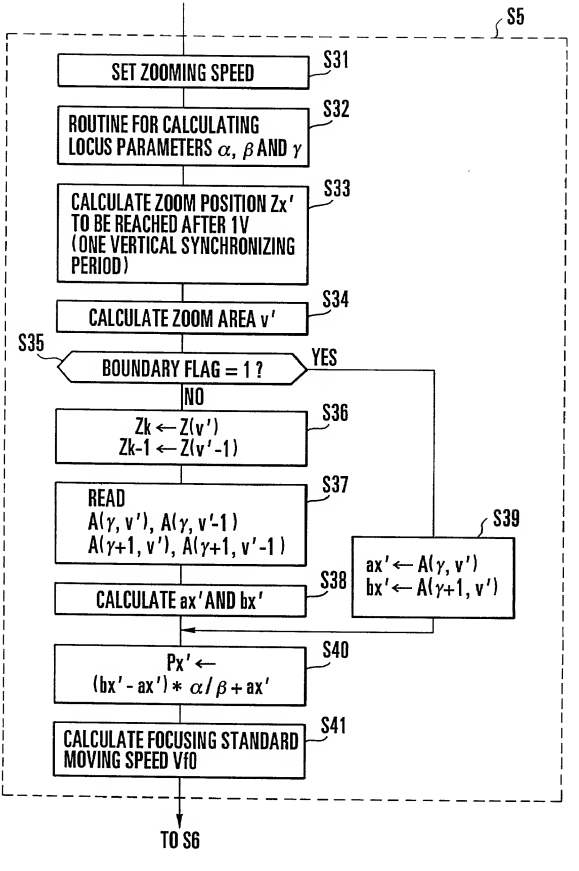

S5
SET ZOOMING SPEED
S31
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S32
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S33
CALCULATE ZOOM AREA v'
S34
S35
BOUNDARY FLAG = 1 ?
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S36
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S37
CALCULATE ax' AND bx'
S38
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S39
Px' ←
(bx' - ax') * α / β + ax'
S40
CALCULATE FOCUSING STANDARD MOVING SPEED Vf0
S41
TO S6

FIG. 10

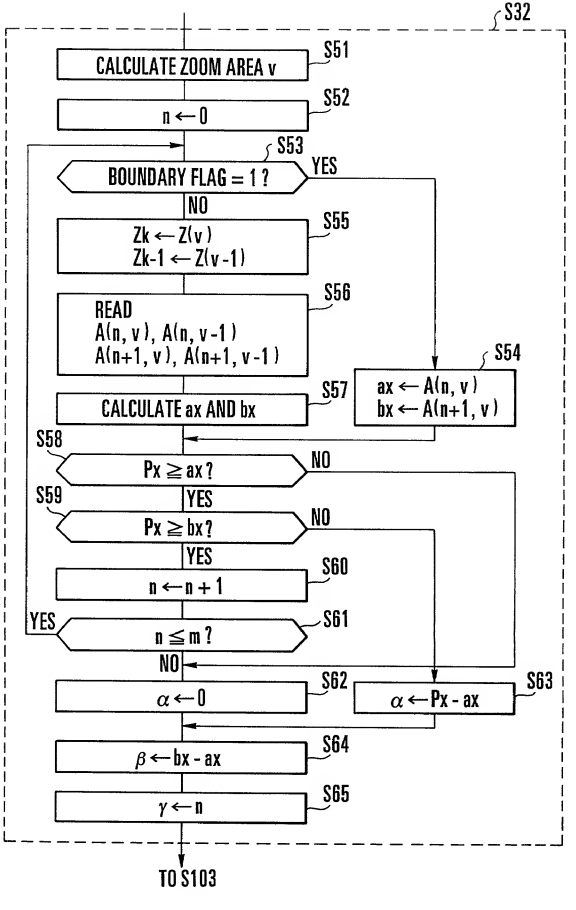

S32
CALCULATE ZOOM AREA v
S51
n ← 0
S52
S53
BOUNDARY FLAG = 1 ?
YES
NO
Zk ← Z(v)
Zk-1 ← Z(v-1)
S55
READ
A(n, v), A(n, v-1)
A(n+1, v), A(n+1, v-1)
S56
S54
ax ← A(n, v)
bx ← A(n+1, v)
S57
CALCULATE ax AND bx
S58
Px ≧ ax ?
NO
S59
YES
Px ≧ bx ?
NO
YES
S60
n ← n + 1
YES
S61
n ≦ m ?
NO
S62
α ← 0
S63
α ← Px - ax
S64
β ← bx - ax
S65
γ ← n
TO S103

FIG. 11

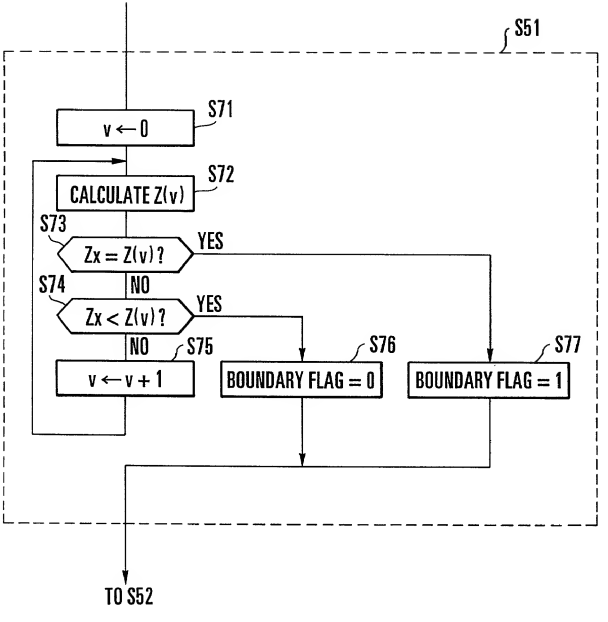
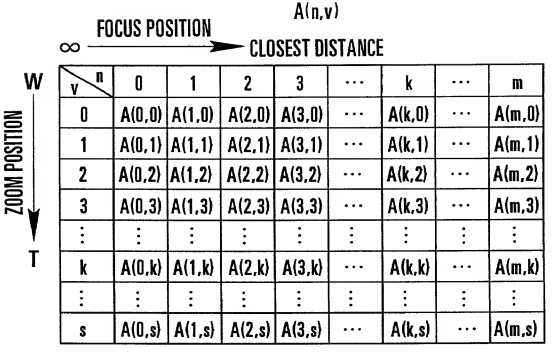

S51
S71
v ← 0
S72
CALCULATE Z(v)
S73
Zx = Z(v) ?
YES
S74
NO
Zx < Z(v) ?
YES
NO
S75
v ← v + 1
S76
BOUNDARY FLAG = 0
S77
BOUNDARY FLAG = 1
TO S52

FIG. 12



v \ n	0	1	2	3	⋯	k	⋯	m
0	A(0,0)	A(1,0)	A(2,0)	A(3,0)	⋯	A(k,0)	⋯	A(m,0)
1	A(0,1)	A(1,1)	A(2,1)	A(3,1)	⋯	A(k,1)	⋯	A(m,1)
2	A(0,2)	A(1,2)	A(2,2)	A(3,2)	⋯	A(k,2)	⋯	A(m,2)
3	A(0,3)	A(1,3)	A(2,3)	A(3,3)	⋯	A(k,3)	⋯	A(m,3)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
k	A(0,k)	A(1,k)	A(2,k)	A(3,k)	⋯	A(k,k)	⋯	A(m,k)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	A(0,s)	A(1,s)	A(2,s)	A(3,s)	⋯	A(k,s)	⋯	A(m,s)

FIG. 13

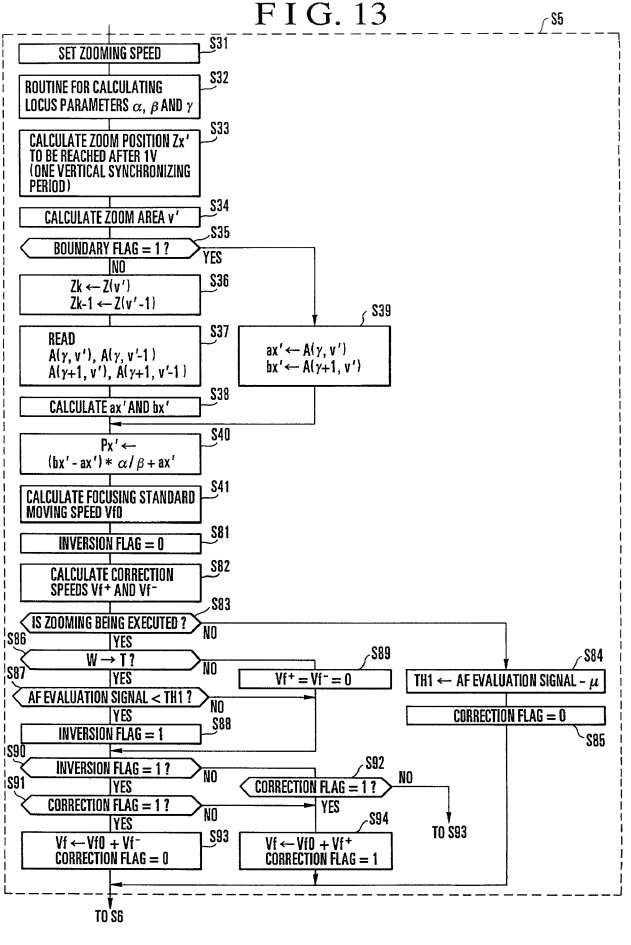
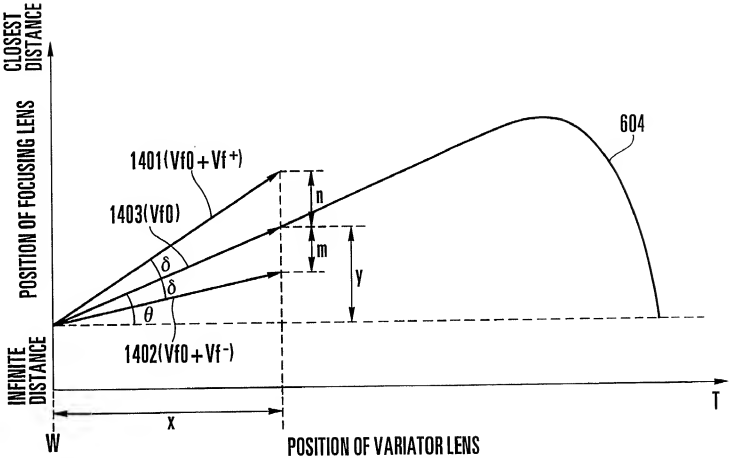
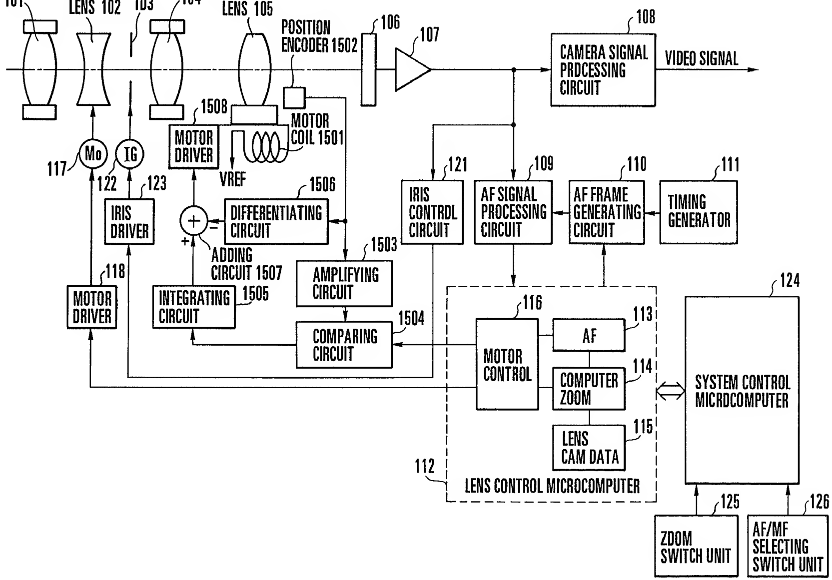

S5
SET ZOOMING SPEED
S31
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S32
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S33
CALCULATE ZOOM AREA v'
S34
BOUNDARY FLAG = 1 ?
S35
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S36
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S37
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S39
CALCULATE ax' AND bx'
S38
Px' ← (bx' - ax') * α/β + ax'
S40
CALCULATE FOCUSING STANDARD MOVING SPEED Vf0
S41
INVERSION FLAG = 0
S81
CALCULATE CORRECTION SPEEDS Vf+ AND Vf-
S82
IS ZOOMING BEING EXECUTED ?
S83
YES
NO
S86
W → T ?
S87
YES
NO
Vf+ = Vf- = 0
S89
TH1 ← AF EVALUATION SIGNAL - μ
S84
AF EVALUATION SIGNAL < TH1 ?
YES
NO
INVERSION FLAG = 1
S88
CORRECTION FLAG = 0
S85
S90
INVERSION FLAG = 1 ?
S91
YES
NO
CORRECTION FLAG = 1 ?
S92
NO
YES
CORRECTION FLAG = 1 ?
YES
NO
TO S93
Vf ← Vf0 + Vf-
CORRECTION FLAG = 0
S93
Vf ← Vf0 + Vf+
CORRECTION FLAG = 1
S94
TO S6

FIG. 14


CLOSEST DISTANCE
POSITION OF FOCUSING LENS
INFINITE DISTANCE
1401(Vf0+Vf+)
1403(Vf0)
1402(Vf0+Vf-)
604
n
m
y
δ
δ
θ
W
x
T
POSITION OF VARIATOR LENS

F I G. 15



101
VARIATDR LENS 102
1D3
104
FOCUSING LENS 105
POSITION ENCODER 1502
106
107
108
CAMERA SIGNAL PRDCESSING CIRCUIT
VIDEO SIGNAL
1508
MOTOR DRIVER
MOTOR COIL 1501
Mo
IG
117
122
123
VREF
1506
IRIS DRIVER
DIFFERENTIATING CIRCUIT
ADDING CIRCUIT 1507
1503
AMPLIFYING CIRCUIT
118
MOTOR DRIVER
INTEGRATING CIRCUIT
1505
1504
COMPARING CIRCUIT
121
IRIS CONTRDL CIRCUIT
109
AF SIGNAL PROCESSING CIRCUIT
110
AF FRAME GENERATING CIRCUIT
111
TIMING GENERATOR
116
MOTOR CONTROL
113
AF
114
COMPUTER ZOOM
115
LENS CAM DATA
112
LENS CONTROL MICROCOMPUTER
124
SYSTEM CONTROL MICRDCOMPUTER
125
ZDOM SWITCH UNIT
126
AF/MF SELECTING SWITCH UNIT

FIG. 16(A)

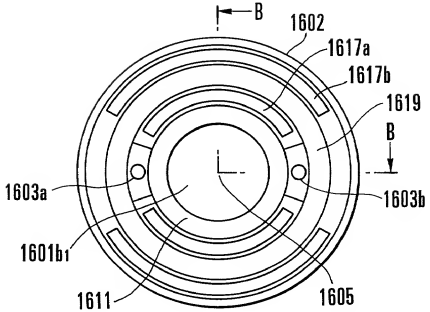


FIG. 16(B)

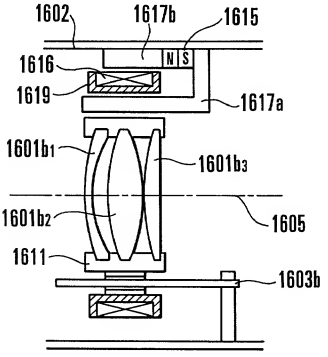


FIG. 17

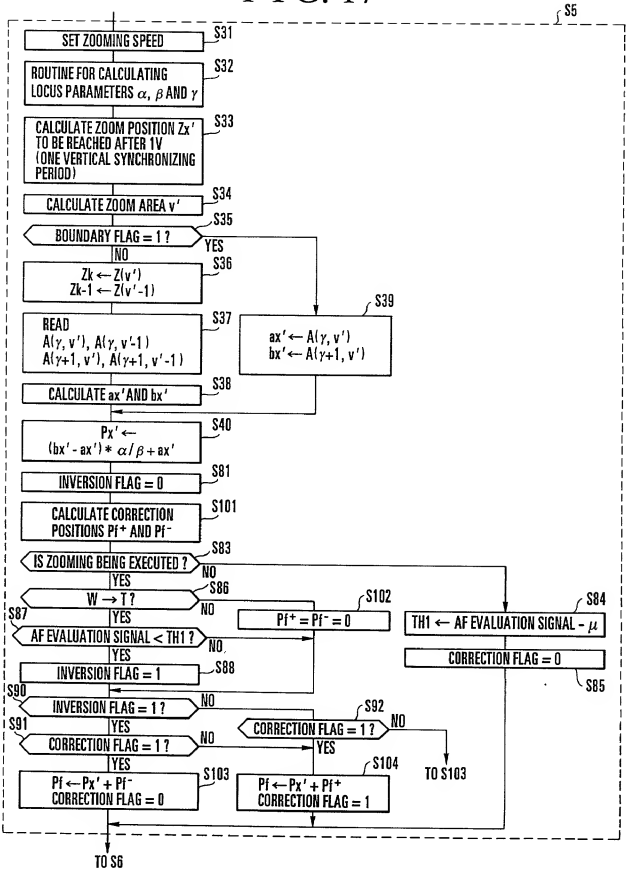

S5
SET ZOOMING SPEED
S31
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S32
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S33
CALCULATE ZOOM AREA v'
S34
BOUNDARY FLAG = 1 ?
S35
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S36
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S37
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S39
CALCULATE ax' AND bx'
S38
Px' ← (bx' - ax') * α/β + ax'
S40
INVERSION FLAG = 0
S81
CALCULATE CORRECTION POSITIONS Pf+ AND Pf-
S101
IS ZOOMING BEING EXECUTED ?
S83
NO
YES
W → T ?
S86
NO
YES
AF EVALUATION SIGNAL < TH1 ?
S87
NO
YES
INVERSION FLAG = 1
S88
INVERSION FLAG = 1 ?
S90
NO
YES
CORRECTION FLAG = 1 ?
S91
NO
YES
Pf ← Px' + Pf-
CORRECTION FLAG = 0
S103
Pf+ = Pf- = 0
S102
CORRECTION FLAG = 1 ?
S92
NO
YES
Pf ← Px' + Pf+
CORRECTION FLAG = 1
S104
TH1 ← AF EVALUATION SIGNAL - μ
S84
CORRECTION FLAG = 0
S85
TO S103
TO S6

FIG. 18

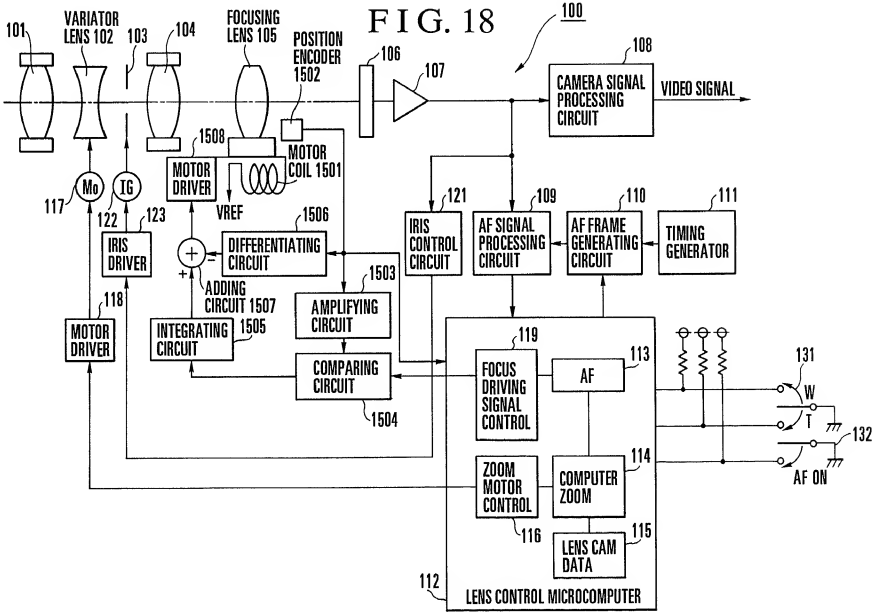


FIG. 19

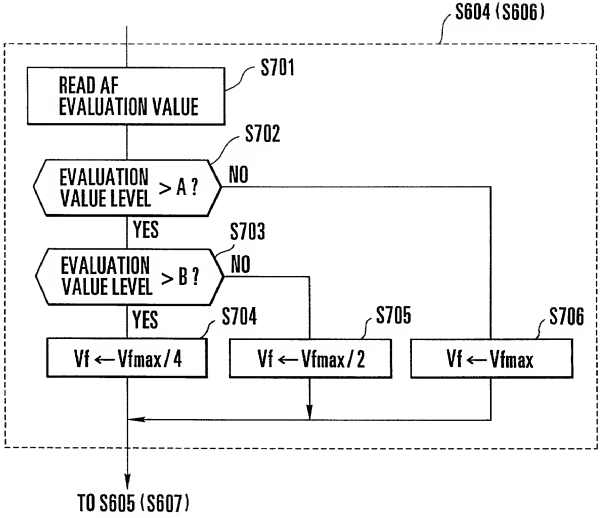

S604 (S606)
READ AF EVALUATION VALUE
S701
EVALUATION VALUE LEVEL > A ?
S702
NO
YES
EVALUATION VALUE LEVEL > B ?
S703
NO
YES
S704
S705
S706
Vf ← Vfmax / 4
Vf ← Vfmax / 2
Vf ← Vfmax
TO S605 (S607)

FIG. 20

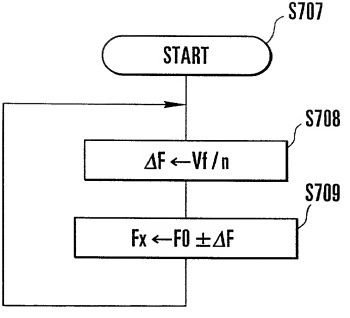


FIG. 21

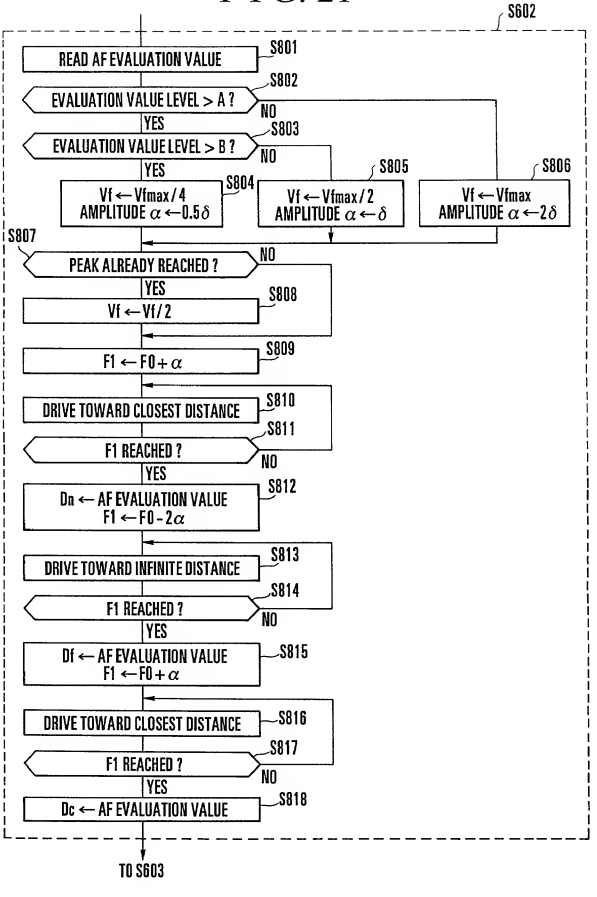

S602
READ AF EVALUATION VALUE
S801
EVALUATION VALUE LEVEL > A ?
S802
NO
YES
EVALUATION VALUE LEVEL > B ?
S803
NO
YES
Vf ← Vfmax / 4
AMPLITUDE α ← 0.5δ
S804
Vf ← Vfmax / 2
AMPLITUDE α ← δ
S805
Vf ← Vfmax
AMPLITUDE α ← 2δ
S806
S807
PEAK ALREADY REACHED ?
NO
YES
Vf ← Vf / 2
S808
F1 ← F0 + α
S809
DRIVE TOWARD CLOSEST DISTANCE
S810
F1 REACHED ?
S811
NO
YES
Dn ← AF EVALUATION VALUE
F1 ← F0 - 2α
S812
DRIVE TOWARD INFINITE DISTANCE
S813
F1 REACHED ?
S814
NO
YES
Df ← AF EVALUATION VALUE
F1 ← F0 + α
S815
DRIVE TOWARD CLOSEST DISTANCE
S816
F1 REACHED ?
S817
NO
YES
Dc ← AF EVALUATION VALUE
S818
TO S603

FIG. 22

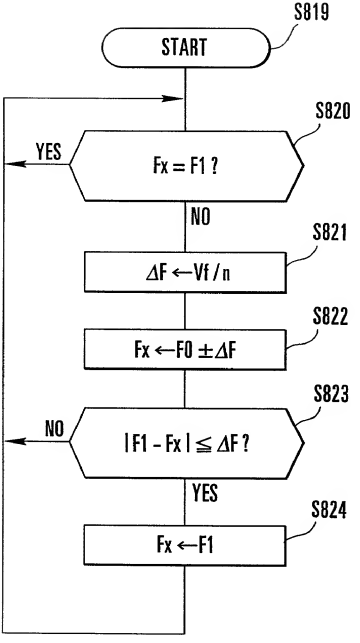

S819
START
S820
YES
Fx = F1 ?
NO
S821
ΔF ← Vf / n
S822
Fx ← F0 ± ΔF
S823
NO
| F1 - Fx | ≦ ΔF ?
YES
S824
Fx ← F1

FIG. 23

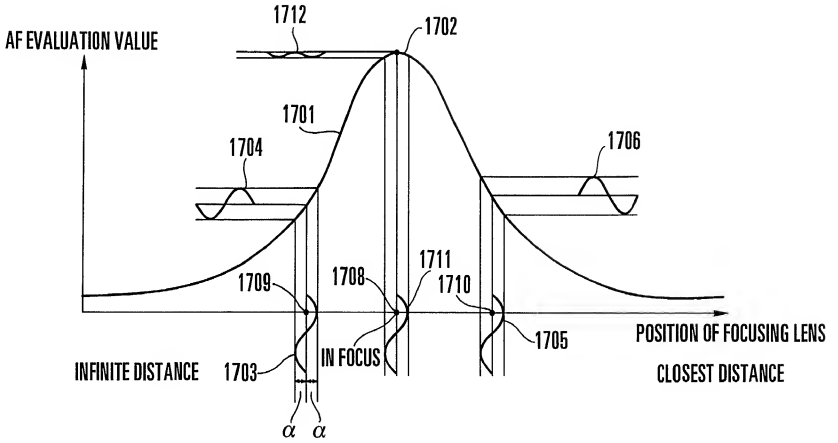

AF EVALUATION VALUE
1712
1702
1701
1704
1706
1709
1708
1711
1710
1705
POSITION OF FOCUSING LENS
INFINITE DISTANCE
1703
IN FOCUS
CLOSEST DISTANCE
α α

FIG. 24

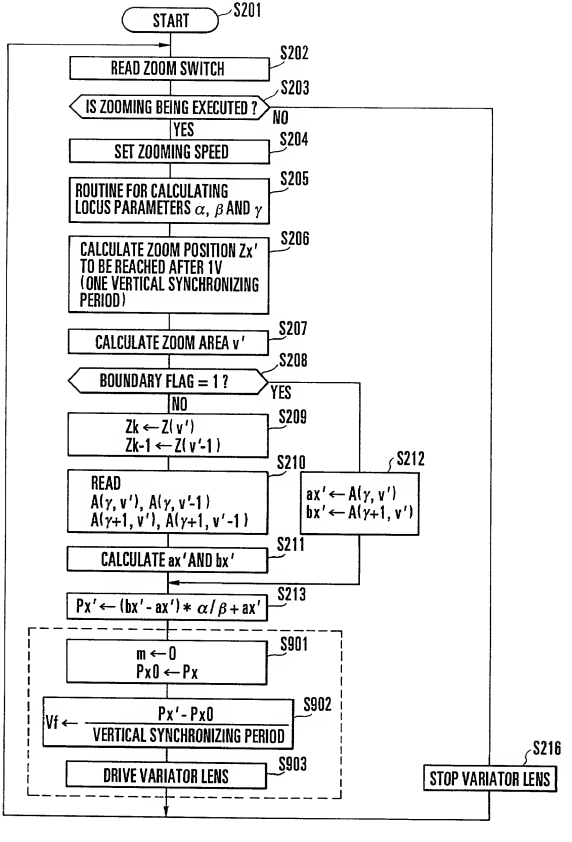

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
S208
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α / β + ax'
S213
m ← 0
Px0 ← Px
S901
Vf ← (Px' - Px0) / VERTICAL SYNCHRONIZING PERIOD
S902
DRIVE VARIATOR LENS
S903
STOP VARIATOR LENS
S216

FIG. 25

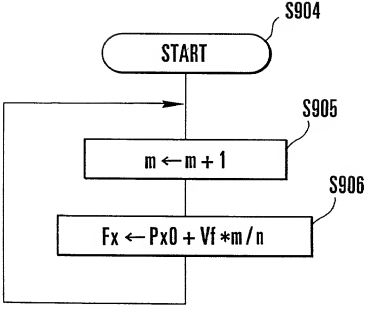


FIG. 26

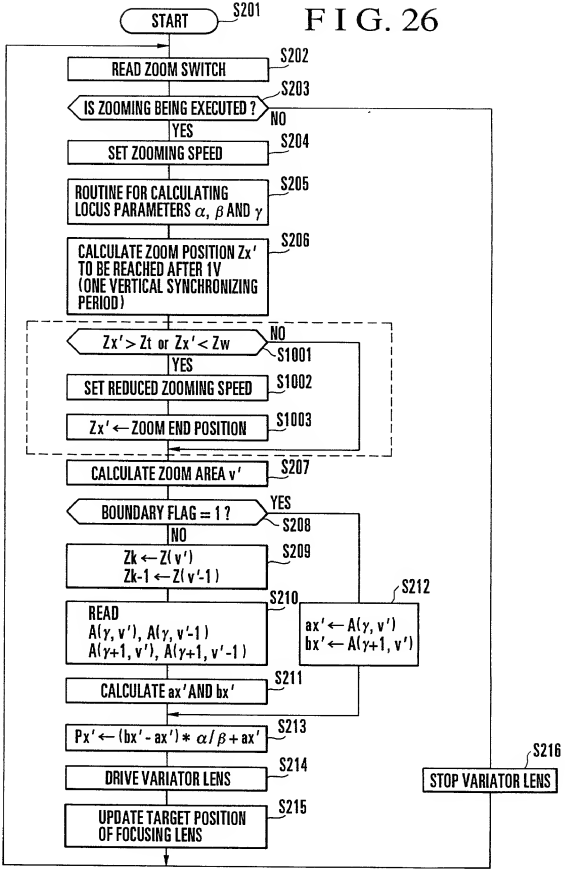

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
Zx' > Zt or Zx' < Zw
NO
S1001
YES
SET REDUCED ZOOMING SPEED
S1002
Zx' ← ZOOM END POSITION
S1003
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
YES
S208
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α/β + ax'
S213
DRIVE VARIATOR LENS
S214
UPDATE TARGET POSITION OF FOCUSING LENS
S215
STOP VARIATOR LENS
S216

FIG. 27

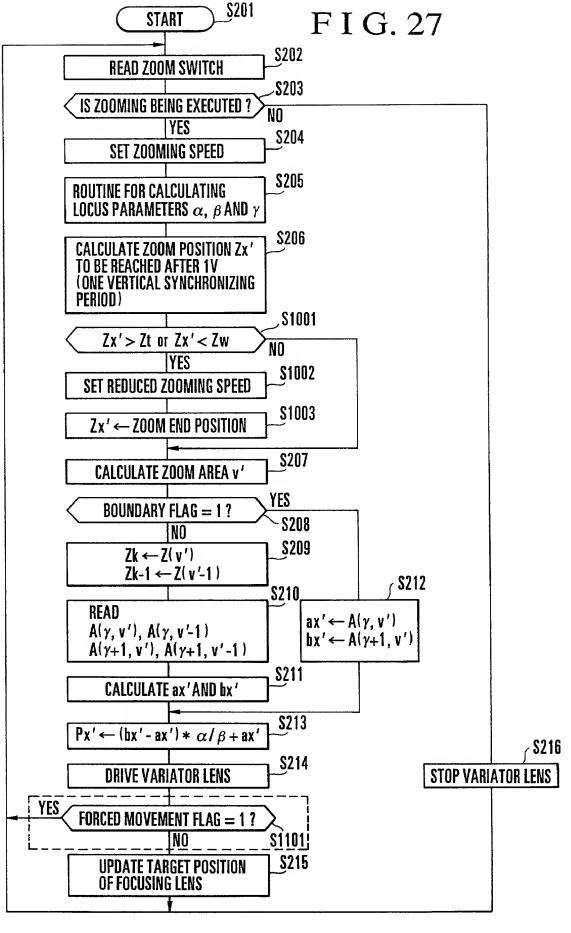

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
Zx' > Zt or Zx' < Zw
S1001
NO
YES
SET REDUCED ZOOMING SPEED
S1002
Zx' ← ZOOM END POSITION
S1003
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
YES
S208
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α/β + ax'
S213
DRIVE VARIATOR LENS
S214
YES
FORCED MOVEMENT FLAG = 1 ?
NO
S1101
UPDATE TARGET POSITION OF FOCUSING LENS
S215
STOP VARIATOR LENS
S216

FIG. 28

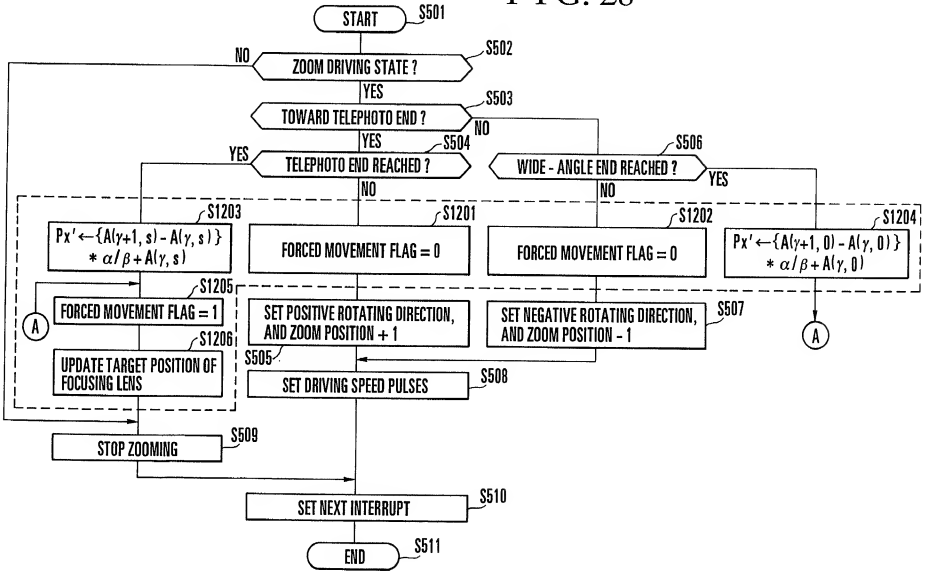

START
S501
ZOOM DRIVING STATE ?
S502
NO
YES
TOWARD TELEPHOTO END ?
S503
NO
YES
TELEPHOTO END REACHED ?
S504
YES
NO
WIDE - ANGLE END REACHED ?
S506
YES
NO
S1203
Px' ← {A(γ+1, s) - A(γ, s)} * α/β + A(γ, s)
S1201
FORCED MOVEMENT FLAG = 0
S1202
FORCED MOVEMENT FLAG = 0
S1204
Px' ← {A(γ+1, 0) - A(γ, 0)} * α/β + A(γ, 0)
S1205
FORCED MOVEMENT FLAG = 1
A
S1206
UPDATE TARGET POSITION OF FOCUSING LENS
SET POSITIVE ROTATING DIRECTION, AND ZOOM POSITION + 1
SET NEGATIVE ROTATING DIRECTION, AND ZOOM POSITION - 1
S507
A
S505
SET DRIVING SPEED PULSES
S508
STOP ZOOMING
S509
SET NEXT INTERRUPT
S510
END
S511

FIG. 29

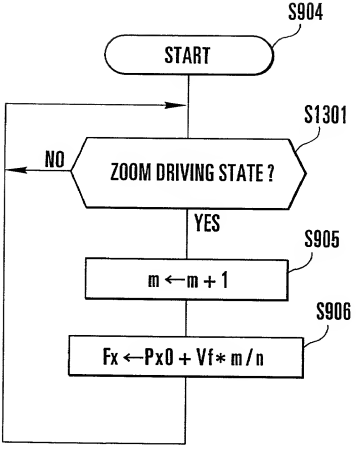

S904
START
S1301
NO
ZOOM DRIVING STATE ?
YES
S905
m ← m + 1
S906
Fx ← Px0 + Vf * m / n

FIG. 30

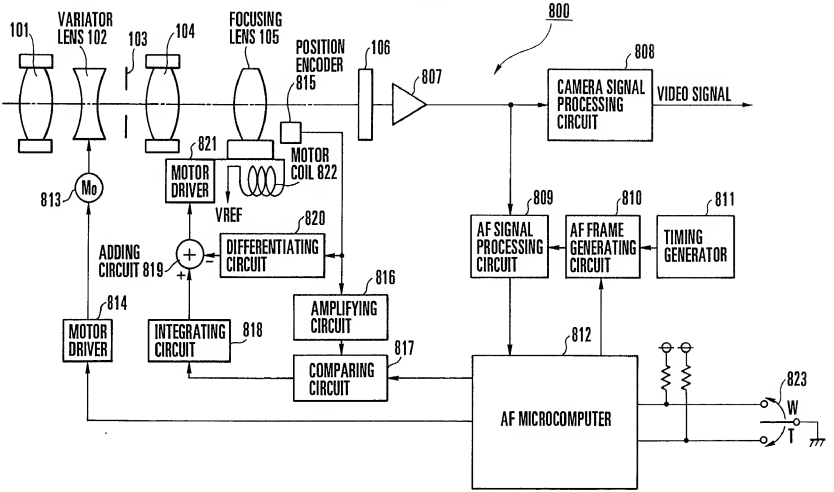


FIG. 31

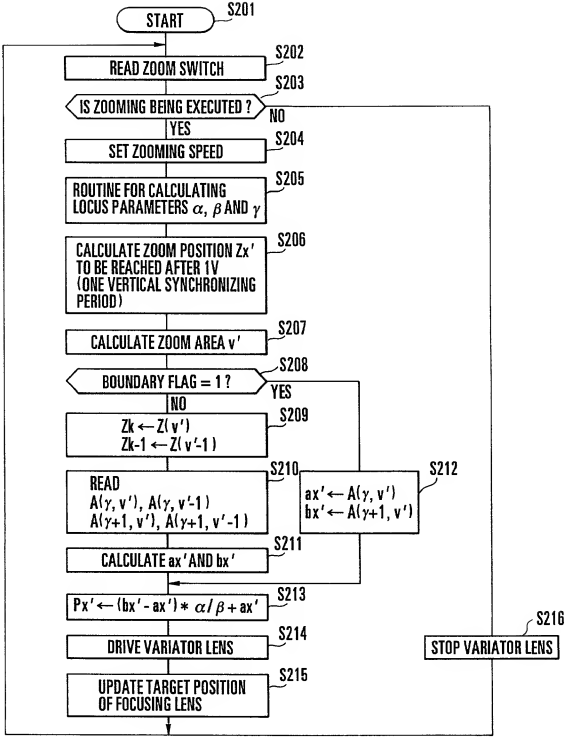

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
S208
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α / β + ax'
S213
DRIVE VARIATOR LENS
S214
UPDATE TARGET POSITION OF FOCUSING LENS
S215
STOP VARIATOR LENS
S216

FIG. 32

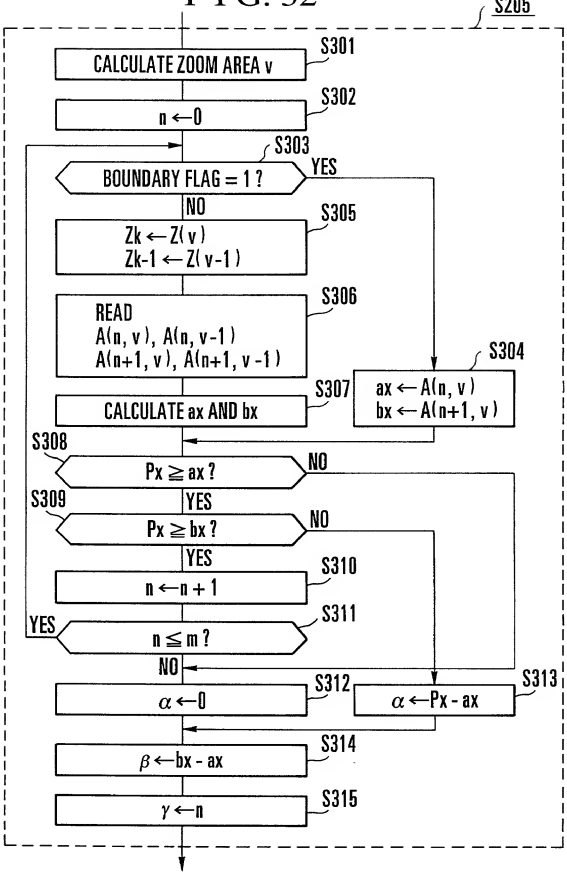

S205
S301
CALCULATE ZOOM AREA v
S302
n ← 0
S303
BOUNDARY FLAG = 1 ?
YES
NO
S305
Zk ← Z(v)
Zk-1 ← Z(v-1)
S306
READ
A(n, v), A(n, v-1)
A(n+1, v), A(n+1, v -1)
S304
ax ← A(n, v)
bx ← A(n+1, v)
S307
CALCULATE ax AND bx
S308
Px ≧ ax ?
NO
S309
YES
Px ≧ bx ?
NO
YES
S310
n ← n + 1
S311
YES
n ≦ m ?
NO
S312
α ← 0
S313
α ← Px - ax
S314
β ← bx - ax
S315
γ ← n

FIG. 33

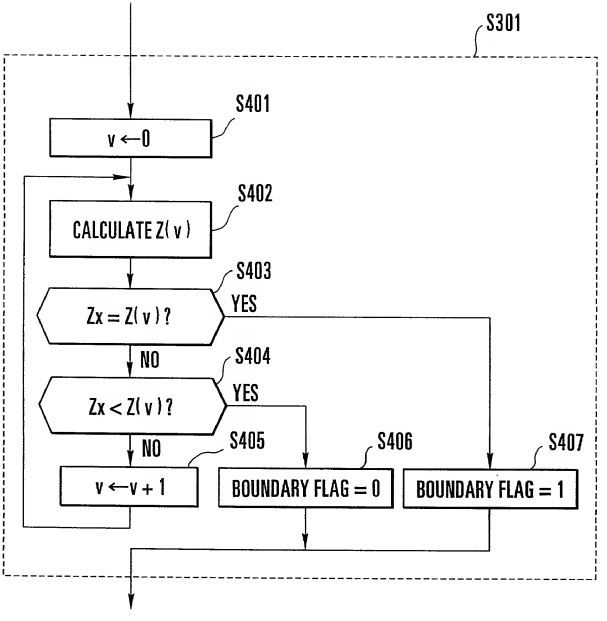

S301
S401
v ← 0
S402
CALCULATE Z(v)
S403
Zx = Z(v) ?
YES
NO
S404
Zx < Z(v) ?
YES
NO
S405
v ← v + 1
S406
BOUNDARY FLAG = 0
S407
BOUNDARY FLAG = 1

FIG. 34

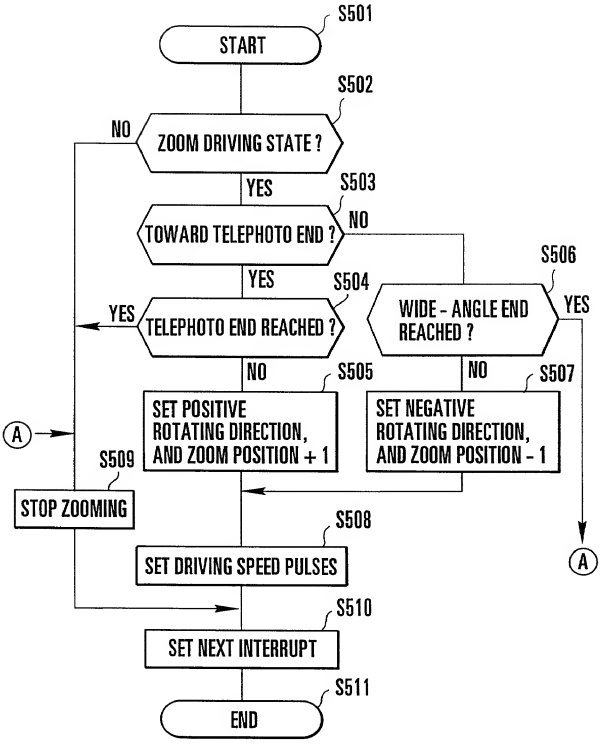
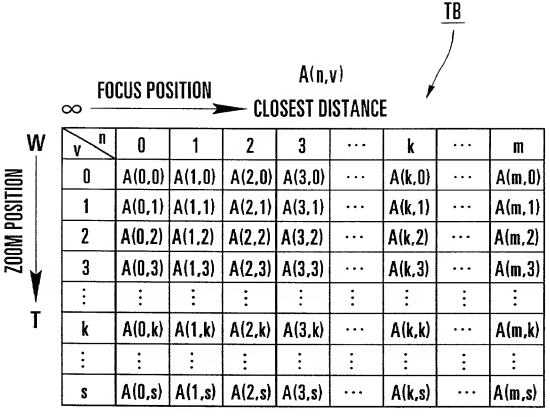
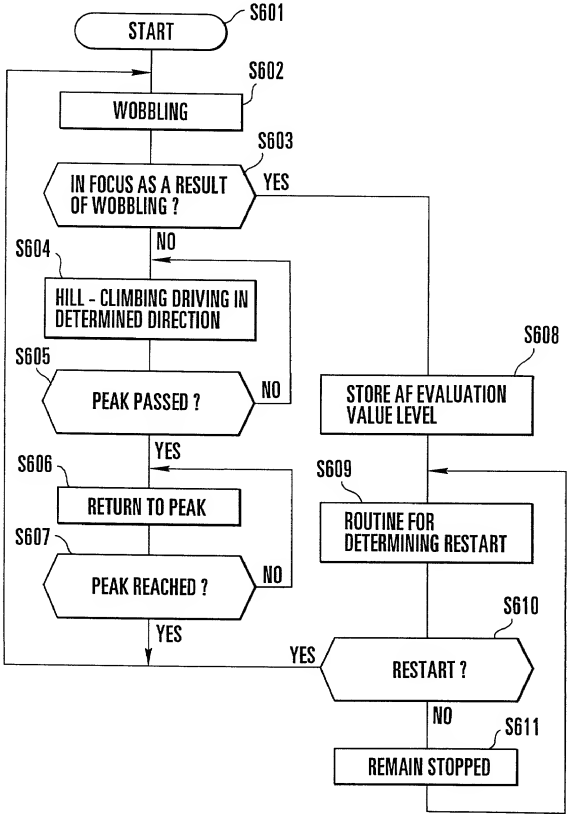

S501
START
S502
ZOOM DRIVING STATE ?
NO
YES
S503
TOWARD TELEPHOTO END ?
NO
YES
S504
TELEPHOTO END REACHED ?
YES
NO
S505
SET POSITIVE ROTATING DIRECTION, AND ZOOM POSITION + 1
S506
WIDE - ANGLE END REACHED ?
YES
NO
S507
SET NEGATIVE ROTATING DIRECTION, AND ZOOM POSITION - 1
A
A
S509
STOP ZOOMING
S508
SET DRIVING SPEED PULSES
S510
SET NEXT INTERRUPT
S511
END

FIG. 35



v \ n	0	1	2	3	⋯	k	⋯	m
0	A(0,0)	A(1,0)	A(2,0)	A(3,0)	⋯	A(k,0)	⋯	A(m,0)
1	A(0,1)	A(1,1)	A(2,1)	A(3,1)	⋯	A(k,1)	⋯	A(m,1)
2	A(0,2)	A(1,2)	A(2,2)	A(3,2)	⋯	A(k,2)	⋯	A(m,2)
3	A(0,3)	A(1,3)	A(2,3)	A(3,3)	⋯	A(k,3)	⋯	A(m,3)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
k	A(0,k)	A(1,k)	A(2,k)	A(3,k)	⋯	A(k,k)	⋯	A(m,k)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	A(0,s)	A(1,s)	A(2,s)	A(3,s)	⋯	A(k,s)	⋯	A(m,s)

FIG. 36


START
S601
S602
WOBBLING
S603
IN FOCUS AS A RESULT OF WOBBLING ?
YES
NO
S604
HILL - CLIMBING DRIVING IN DETERMINED DIRECTION
S605
PEAK PASSED ?
NO
YES
S606
RETURN TO PEAK
S607
PEAK REACHED ?
NO
YES
S608
STORE AF EVALUATION VALUE LEVEL
S609
ROUTINE FOR DETERMINING RESTART
S610
YES
RESTART ?
NO
S611
REMAIN STOPPED